AD

TECHNICAL REPORT
NATICK/TR/79/040

(12)

LEVEL II

EVALUATION OF ALTERNATIVE FIELD FEEDING SYSTEMS FOR ARMY FIELD MEDICAL UNITS

by

H. J. Kirejczyk
T. S. Bonczyk
G. Hertweck
L. Symington

Approved for public release;
distribution unlimited.

JULY 1978

UNITED STATES ARMY
NATICK RESEARCH and DEVELOPMENT COMMAND
NATICK, MASSACHUSETTS 01760

Operations Research and Systems Analysis Office

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 14 NATICK/TR-79/040	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 6 9 EVALUATION OF ALTERNATIVE FIELD FEEDING SYSTEMS FOR ARMY FIELD MEDICAL UNITS.		5. TYPE OF REPORT & PERIOD COVERED 9 Technical rept. 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) 10 Harry J. Kirejczyk, Thaddeus S. Bonczyk, [redacted] Gerald Hertweck L. Symington		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Natick Research and Development Command Natick, Massachusetts 01760		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 6.2 16 1Y762724AH99A
11. CONTROLLING OFFICE NAME AND ADDRESS Operations Research and Systems Analysis Office US Army Natick Research and Development Command Natick, MA 01760		12. REPORT DATE 11 Jul[redacted]78 13. NUMBER OF PAGES 56
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) 12 58 392 674		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

DDC
RECEIVED
DEC 28 1979
A

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

DOD Food RDT&Eng Program. JSR AM 3-1 APPENDIX A, Analysis and Design of Army Medical Field Feeding Subsystem

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

FOOD	ARMY	COMBAT OPERATIONS
FIELD FEEDING	MEDICAL UNITS	WARFARE
MILITARY FEEDING	MEDICAL SERVICES	COMBAT FEEDING SYSTEMS
FEEDING	TRAINING	FOOD SERVICE SYSTEMS

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The goals of this project were to define, develop and evaluate alternatives to the present M48 field feeding system employed by Army medical units in training and combat. These alternative system designs would not only eliminate the major problems and deficiencies associated with the M48 system, but would be capable of being implemented in the near future without engaging in a major research and development program. To this end, various modifications of two recently developed combat food service systems for the Marine Corps and the Army the XM-75 and the MKT, in combination with several ward delivery options were

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

392 674

alt

considered. An operational evaluation was conducted at Fort Sam Houston in June 1977, under simulated field conditions, to assess their performance and effectiveness and to provide a basis for establishing the preferred alternatives for the different medical units. The result has been to recommend the modified XM-75 system for Combat Support Hospitals, and the reduced XM-75 for non-hospital medical units operating in the forward division area.

AD

Technical Report
Natick/TR/79/040

EVALUATION OF ALTERNATIVE FIELD FEEDING SYSTEMS FOR ARMY FIELD MEDICAL UNITS

by

H. J. Kirejczyk

T. S. Bonczyk

G. Hertweck

L. Symington

July 1978

Approved for public release;
distribution unlimited.

UNITED STATES ARMY
NATICK RESEARCH AND DEVELOPMENT COMMAND
NATICK, MASSACHUSETTS 01760

Operations Research and Systems Analysis Office

PREFACE

The results of an evaluation of alternative food service systems for supporting Army field medical units and hospitals in training or combat are presented in this report. The evaluation involved four versions of the XM-75 and MKT systems, originally designed for Marine Corps and Army field feeding requirements, modified to meet the particular needs of medical food service. Three delivery options for transporting meals from the field kitchen to nonambulatory patients on the wards were considered in conjunction with these alternative systems. Data derived from the evaluation were analyzed and compared to determine the preferred alternatives for the different types of units.

This work was performed in response to a requirement from the Office of The Surgeon General, JSR AM 3-1, Appendix A, Analysis and Design of Army Medical Field Feeding Subsystem, under Project No. 1Y762724AH99A, DOD Food Research, Development, Testing, and Engineering Program.

The outstanding support and cooperation of COL J. H. Ferguson, Academy of Health Sciences, COL E. J. Carmick, Chief, and CPT L. Devendorf, Project Officer, Medical Equipment Test and Evaluation Division, Medical Materiel Agency, and CW4 R. O'Day, Services Division in the planning and conduct of the operational evaluation at Fort Sam Houston, Texas are gratefully acknowledged.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EVALUATION OF ALTERNATIVE FIELD FEEDING SYSTEMS FOR ARMY FIELD MEDICAL UNITS

CHAPTER I

INTRODUCTION

An urgent need exists for a modern food service system to support Army field medical treatment facilities. The standard M48 field feeding system, as presently employed by Army medical units in training and combat, dates back to World War II, and is generally considered to be ineffective and obsolete. Among the more obvious deficiencies are that the M48 kitchen tent is very difficult and time-consuming to erect and strike because of its odd configuration and many different sized components; the authorized kitchen equipment is somewhat limited and is inadequate to support the total menu requirements, which includes both special and modified diets; the sanitation equipment provided is insufficient for this purpose; and, the insulated food container is an inefficient means of delivering and serving meals to nonambulatory patients on the wards.

The MUST (Medical Unit Self-Contained) food service complex was designed and developed as an intended replacement for the M48 system. However, after extensive testing and evaluation, it has been determined to be unacceptable primarily for reasons of complexity, and because of excessive weight and cube. Therefore, the Office of The Surgeon General submitted a requirement to the DoD Food RDT&Engineering Program (Project No. 1Y762724AH99A, JSR AM 3-1, Appendix A, Food Service Systems for Army and Marine Corps in the Field) to define and evaluate alternative system designs based on existing technology, hence requiring no major research and development efforts, which can be implemented in the short range future. These new system designs would essentially eliminate the principal problems identified with the M48 field feeding systems, as well as reduce food service personnel requirements, increase the quality of food service to patients under combat conditions, improve sanitation operations, and, provide a generally better working environment for military cooks.

Typically, field medical facilities operate company level kitchens, even though the actual food service requirements may range up to about 800 patients, staff and attached support personnel, as shown in Table 1. Food service for the staff and ambulatory patients is conducted in a conventional manner from a kitchen tent and serving lines. However, nonambulatory patients are served on the ward, for which the meal requirements are highly variable. A ward is designed to house up to

twenty patients, both ambulatory and nonambulatory, some of which are on prescribed, modified diets, while others have no dietary restrictions. A division medical facility may support from two to twenty wards, depending upon the type of unit being considered. Appropriate foods and meals must be prepared in the kitchen tent, assembled and delivered in the standard insulated food containers to each ward, and there served to each patient. Sanitation of pots and pans, utensils, mess gear and all other items is accomplished utilizing GI cans and immersion heaters as the primary equipment.

Alternative system designs were derived through modification of two recently developed combat food service systems for the Army and the Marine Corps. The XM-75 field feeding system was designed for battalion level operations by the Marine Corps.[1] The kitchen is a lightweight, frame-supported shelter, which includes, in addition to the standard kitchen equipment, other new items such as work tables, steam tables, griddles, and an electric meat slicer and vegetable cutter, to provide for greater operational flexibility and efficiency. An integral element of the XM-75 system is the new sanitation center, which is housed in a shelter of the same basic design as the kitchen shelter, containing field sinks, drying and storage racks for cleaned pots, pans and other cooking utensils, and provides a continuous supply of hot water. The modifications to the XM-75 system for medical food service were primarily added equipment to support patient feeding requirements at the Combat Support Hospital level. A reduced version of the modified XM-75 would be utilized in non-hospital medical units.

The Mobile Kitchen Trailer (MKT), developed for company level feeding operations by the Army[2], is fitted out with standard field kitchen equipment. Shelter is provided by a manually raised roof with fabric sides and screens. Modifications for medical food service involved equipping the MKT in the same manner as the XM-75, including a sanitation center. For Combat Support Hospitals, two MKT units would be configured for ward patient feeding and for feeding staff and ambulatory patients; while a single MKT would be adequate to perform these functions in the smaller non-hospital medical units.

---

[1] S. Baritz, R. Bustead, H. Kirejczyk, M. Kulinski, H. Meiselman, G. Silverman, R. Smith, I. Stefaniw and L. Symington, "The Camp Pendleton Experiment in Battalion Level Feeding", Technical Report Natick/TR-7T-4-ORSA, US Army Natick Research and Development Command, Natick, MA 01760, July 1976.

[2] H. Kirejczyk, S. Baritz, R. Byrne, M. Kulinski, R. Smith and I. Stefaniw, "A Cost and Systems Effectiveness Analysis of Consolidated Field Feeding for Army AIM Divisions", Technical Report NATICK/TR-77/003, US Army Natick Research and Development Command, Natick, MA 01760, October 1976.

TABLE 1

FOOD SERVICE REQUIREMENTS

Unit	Units/Division	Staff	Patients[a]	Others[b]	Total
Medical Company Medical Battalion	3	82	40	12	134
HQ & Support Company Medical Battalion	1	146	40	19	205
Combat Support Hospital	2	230	200	43	473
Evacuation Hospital	1	318	400	72	790

[a]It is assumed that 25% of the patient load will receive special or modified diets.

[b]This category includes all personnel temporarily assigned or attached to a unit.

Commercially available insulated trays and a portable insulated serving line, developed especially for this project, were considered as possible options to the standard insulated food container for delivering meals to patients on the wards. Meals are individually assembled on the insulated trays in the kitchen, which are then stacked and strapped, and delivered to the ward and served to the patients. Beverages are transported in separate containers, to be portioned and served with the meals. When using the portable serving lines, food is delivered to the wards in bulk, and then assembled on regular individual trays and served to the patients. Beverages are handled separately, as with the insulated trays. Either the insulated trays or the portable serving line may be used in conjunction with both the modified XM-75 and MKT configured systems.

In June 1977, an operational demonstration and evaluation was conducted at Ft. Sam Houston, Texas to assess the performance and effectiveness of these alternative systems under simulated field conditions. This report briefly describes and summarizes the results of that evaluation. It was concluded that the XM-75 system concepts were most effective for combat hospital food service operations, and performed equally as well as the MKT system when providing food service support to the non-hospital medical units. Thus, the modified XM-75 is recommended as the preferred alternative for Army field medical treatment facilities. However, neither the insulated trays nor the portable serving line were superior to the standard insulated food container as patient meal delivery systems. Further research and development is required to resolve the problems in this area.

CHAPTER II

SYSTEMS DESCRIPTIONS

BACKGROUND

The standard M48 field feeding system, which is now being used to support food service requirements of Army medical and hospital units in the field or combat is obsolete in both concept and design.[3]

a. The kitchen shelter is a high ridge pole tent, difficult to erect and strike, and not well suited for operations in inclement weather. Access is highly restricted by small doorways at each end of the tent, and the complete lack of any other openings severely limits ventilation and natural lighting. Functional space is constrained by the tent design, so that multiple shelters are needed for food service operations in combat support hospitals or larger medical units.

b. Authorized equipment includes only the M59 field range cabinet with M-2 burners and cook kit; i.e., pots, pans and other utensils. The range is converted to a grill by fitting a squarehead lid to the top of the cabinet. No work tables are provided for food preparation or serving purposes. Typically, food service personnel augment these resources with other unauthorized equipment and resort to field expedients to prepare and serve the menu.

c. Immersion heaters in 32-gallon GI cans are the primary source of hot water for cleaning cooking equipment, mess gear, and patient trays and utensils. This is a generally unsatisfactory method of sanitation, for it is difficult to maintain water temperatures at sufficiently high levels to insure that items immersed are properly cleansed and sanitized. Also, many items of equipment cannot be immersed and must be washed outside the GI can, often with poor results. No provision is made for sheltering the washing operations or drying and storing cleaned items, which in many situations further degrades the quality of sanitation. These problems are particularly apparent in field hospital units where large quantities of cookware and patient trays must be cleaned.

d. In medical operations, the field kitchen must prepare and serve various types and quantities of special food and diets to patients. Equipment required for this purpose, e.g., choppers, blenders or strainers, are not contained within the standard M48 field feeding system.

---

[3]Ibid.

e. Standard insulated containers used to deliver rations from the field kitchen to the wards are not efficient for transporting small quantities of food items, as required for those patients on special or modified diets.

The MUST Service Complex was developed to improve upon the quality of hospital food service provided in the field by the M48 system. The kitchen, stored and transported in an expandable shelter, consisted of electric food service equipment, including griddle, convection oven, tilting fry pan, steam kettle, vertical cutter/mixer, along with a small steam kettle, blender, hot plate, and a food warming cabinet for special diets. The serving line and dining area were contained in additional inflatable shelter sections. The serving line included a griddle, toaster, coffee maker, hot and cold food serving units, soft serve ice cream machine, ice maker, work tables, and various beverage dispensers. Twenty tables with benches were provided for staff and ambulatory-patient dining. A ward food service unit equipped with toasters, griddle, coffee maker, microwave ovens, various dispensers, and work tables was provided to prepare and serve regular menu items, supplemental nourishments and special diets.

The MUST Food Service Complex was initially evaluated with decentralized patient tray service. Bulk food was portioned in the kitchen into insulated food and beverage containers, and then transported to the ward food service unit. There, ward food service personnel assembled the bulk items onto individual patient trays, prepared and added single serve items, such as eggs and toast, loaded the trays into carriers, transported the carriers to the wards, and served them to the patients. Decentralized patient tray service was rejected as impractical for the field because of the large workload imposed on the ward food service unit, and the difficulty of maintaining food temperatures with the excessive amount of food handling from the kitchen to the patient.

Next, centralized patient tray service was evaluated, in which the food was prepared, portioned onto disposable, compartmented trays, loaded into tray cases, and refrigerated until transported to the wards. There the food was reheated in microwave ovens prior to being served to the patients. This mode of operation, although feasible, greatly increased the work of kitchen personnel while decreasing the workload on ward personnel.

After extensive field testing and evaluation, the MUST Food Service Complex was not accepted as a standard item because of its excessive weight/cube and considerable complexity, with the resulting implications for reliability, maintainability, and supportability of the system.

At the same time, other new developments in combat field feeeding became available; notably the MKT and XM-75 systems. Consequently, a project was initiated to identify the major problem areas associated with the M48 system; to identify alternatives, which could be adopted in the near term without further research and development effort; and to demonstrate and evaluate these alternatives to recommend the preferred system to support field medical unit food service requirements. The XM-75 and MKT, originally designed for Marine Corps and Army combat forces were appropriately modified for this purpose. A brief description of each candidate system is presented below.

XM-75 SYSTEMS

The modified XM-75 kitchen shelter is a lightweight sectional, expandable frame-type tent (FSN 8340-782-3232). Alterations were made to provide improved access, better ventilation, increased workspace, and protection against solar radiation. The XM-75 shelter consists of five 18'W x 8'L sections, but may be expanded to any desired length in eight foot increments. Doorways are provided, two at each end, and one on each side of both the first and third sections, with zippered fabric panel closures and screened panels with velcro closures. The remaining three sections have permanently screened windows on both sides, with clear plastic and fabric panels with velcro closures for inclement weather and blackout conditions. Window fabric, plastic window panels, doorway fabric, and doorway screens can be rolled up and tied when desired. Each section has a large screened vent with fabric covering on each side of the roof panel at the ridge line. The fabric covering is adjustable from inside the shelter to provide the desired amount of ventilation. Solar radiation, environmental, and blackout protection is provided by a sectionalized fly, supported approximately twelve inches above the tent roof by metal extenders at the ridge and eave lines of the tent. Four sections of the shelter comprise the field kitchen, while the last section is intended for ration storage purposes.

An exterior view of the modified XM-75 kitchen is depicted in Figure 1, and Figure 2 illustrates the layout of the kitchen. The major items of equipment are delineated in Table 2. It should be noted that the equipment is modular, providing considerable flexibility in equipping and layout of field kitchens for different types and sizes of units, and permitting rapid changes in serving line arrangements to meet varying menu requirements, if desired.

A reduced XM-75 kitchen utilizes the same basic shelter, with only two eight-foot sections; a door section and a window section. The food preparation equipment is essentially the same, but the quantity of each item has been reduced consistent with the smaller number of personnel to be supported, Table 3. Labor saving devices, such as the meat slicer, vegetable cutter, blender, and can opener, and the soft serve ice cream machine and the ice makers were also eliminated from the reduced XM-75 since it is intended for non-hospital medical units with reduced feeding requirements. Figures 3 and 4 show the exterior view and layout of the reduced XM-75.

The XM-75 includes a sanitation center for washing and sanitizing pots and pans, ward delivery and serving equipment, utensils, and any other items of food service equipment. It is housed in the same basic tent as the kitchen, but consists of only two-eight foot window sections. The equipment is listed in Table 4. The wash line contains four stainless steel field sinks and three drain tables. The four sinks are for prewash, wash, rinse, and sanitizing rinse, and are large enough to immerse the largest cookware currently in use. A series of five plastic pallets are installed as flooring along the wash line. A standard water heater, modified to operate automatically and unattended, provides a continuous supply of hot water. A pump, coupled with a series of hoses and valves, distributes hot and cold water directly from a standard 400-gallon water trailer to the sanitation center. Metal cradles support the field sinks and hold M-2 burners for proper temperature maintenance. Four sets of wire shelving are set up in the sanitation center for storing and drying sanitized items. An exterior view of the sanitation center is contained in Figure 5, and Figure 6 shows the layout.

MKT SYSTEM

The MKT is a self-contained, trailer-mounted field kitchen consisting of standard field feeding equipment to provide three hot meals daily for up to company level, i.e., 250 individuals. Horizontal expansion of the MKT provides the necessary working area and serving line, sheltered by a manually raised roof with fabric sides and screening. Roof vents allow hot air and combustion gases to escape. The M103A3 trailer chassis can be towed by a standard 2-½ ton truck. The major items of equipment included with the MKT are listed in Table 5. Additional labor saving devices were added to the MKT, i.e., electric vegetable cutter, meat slicer, blender, and can opener, identical with the modified XM-75 System. Ice makers and soft serve ice cream machines are not located on the MKT because of lack of available space. Figure 7 is an exterior view of the MKT, and Figure 8 the equipment layout.

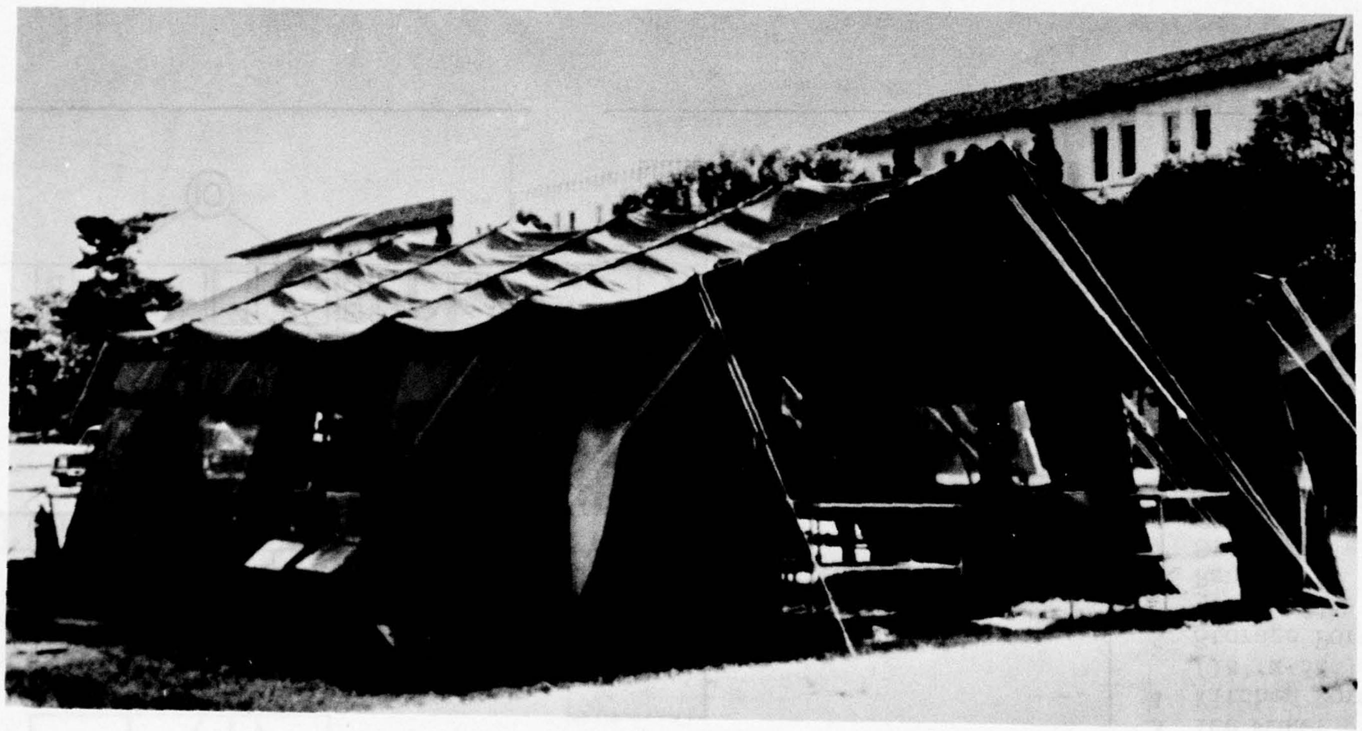

Figure 1. EXTERIOR VIEW OF MODIFIED XM-75

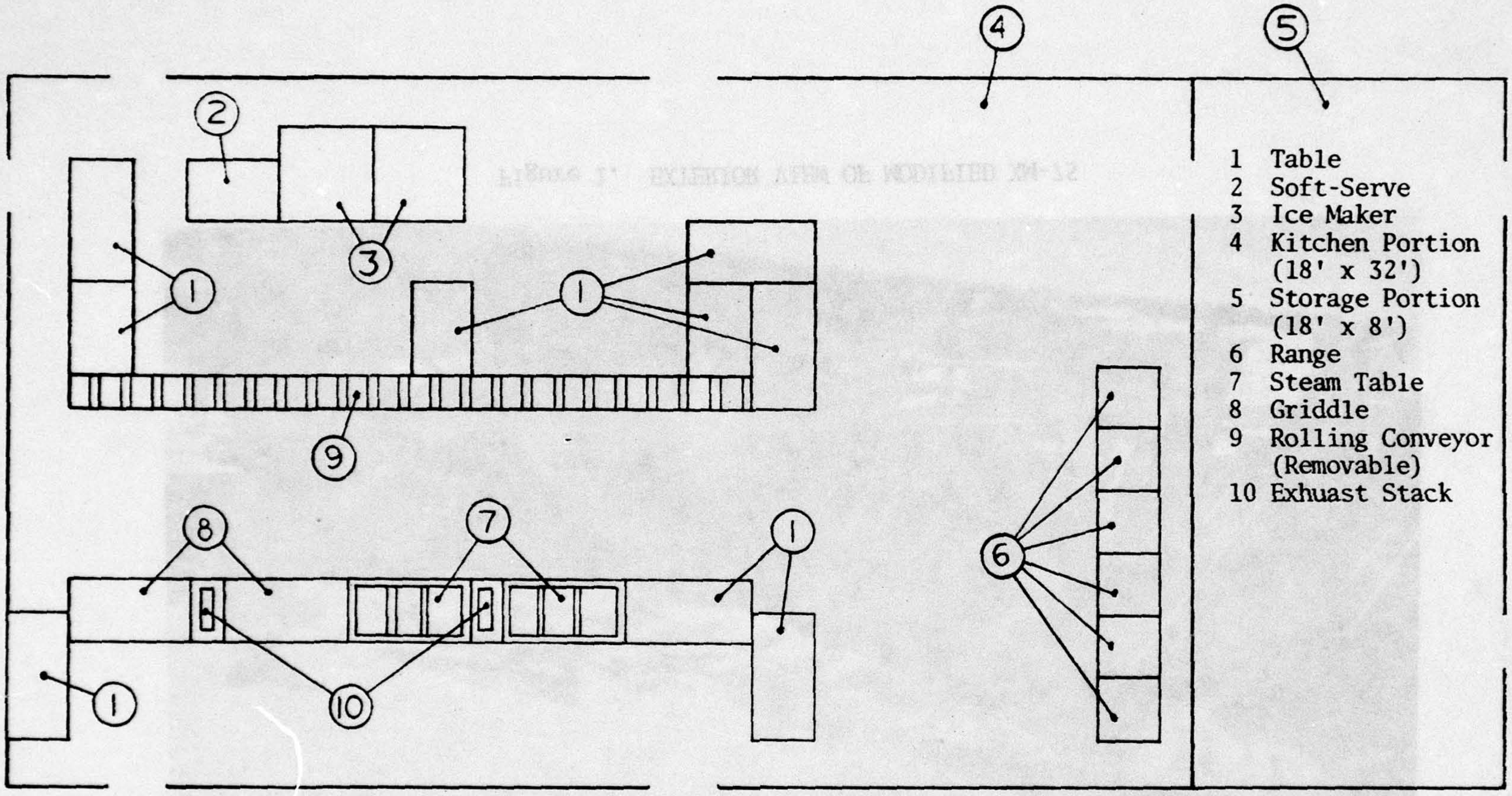

Figure 2. LAYOUT OF MODIFIED XM-75

TABLE 2

MODIFIED XM-75

MAJOR EQUIPMENT ITEMS

Item	Number
Griddle	2
Steam Table	2
Table, Stainless Steel	9
Field Range, w/M-2 Burner Unit	6
Burner Unit, M-2	6
Vegetable Cutter, Blender	1
Meat Slicer, Electric	1
Blender, Electric	1
Can Opener, Electric	1
Ice Maker	2
Soft Serve Machine	1
Refrigerator, 450 ft^3	1

TABLE 3

REDUCED XM-75

MAJOR EQUIPMENT ITEMS

Item	Number
Griddle	1
Steam Table	2
Table, Stainless Steel	6
Field Range, w/M-2 Burner Unit	3
Burner Unit, M-2	3

20

Figure 3. EXTERIOR VIEW OF REDUCED XM-75

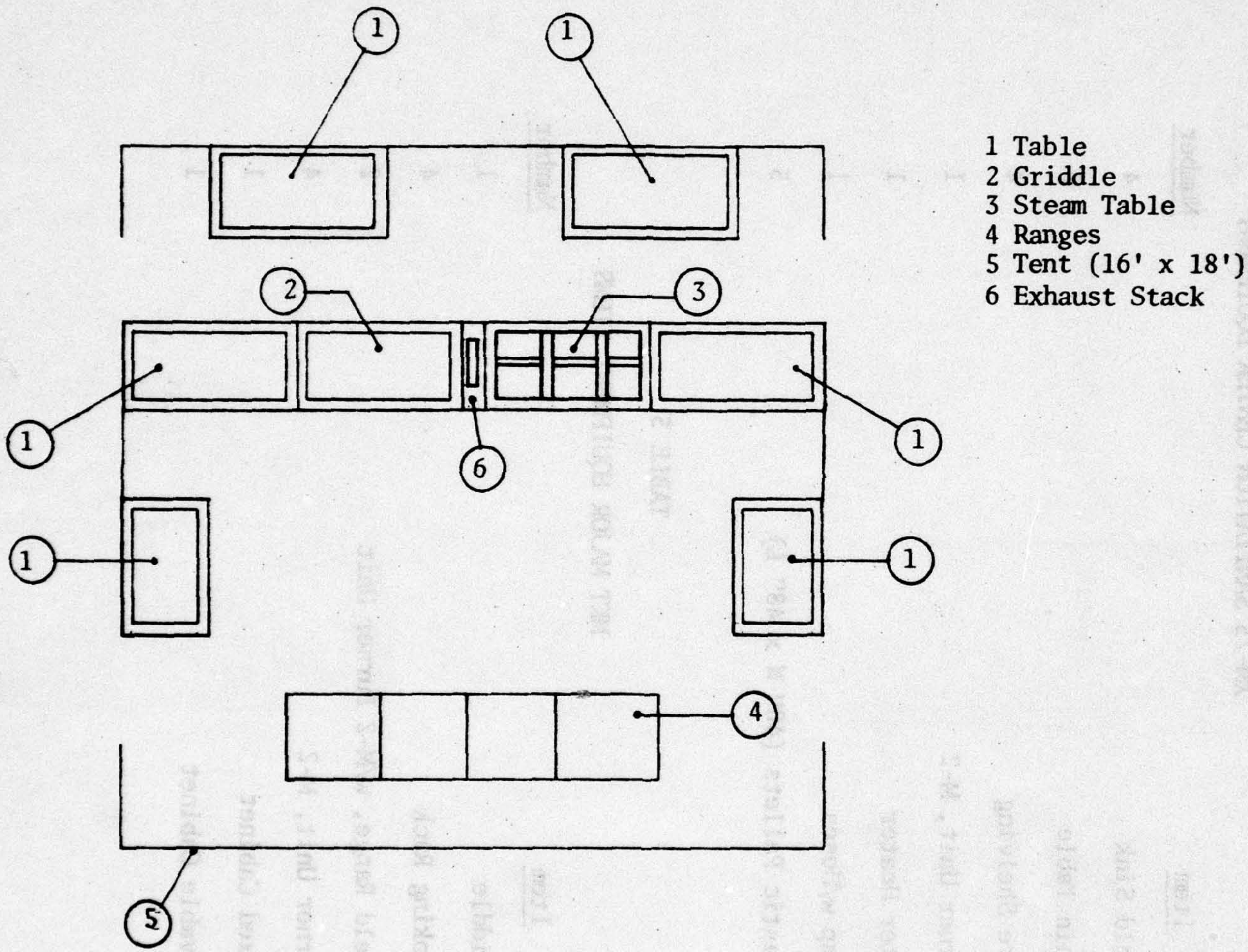

Figure 4. LAYOUT OF REDUCED XM-75

TABLE 4

XM-75 SANITATION CENTER EQUIPMENT

Item	Number
Field Sink	4
Drain Table	3
Wire Shelving	4
Burner Unit, M-2	1
Water Heater	1
Pump w/Hoses	1
Plastic Pallets (40" W x 48" L)	5

TABLE 5

MKT MAJOR EQUIPMENT ITEMS

Item	Number
Griddle	1
Cooking Rack	4
Field Range, w/M-2 Burner Unit	2
Burner Unit, M-2	4
Fixed Cabinet	1
Movable Cabinet	1

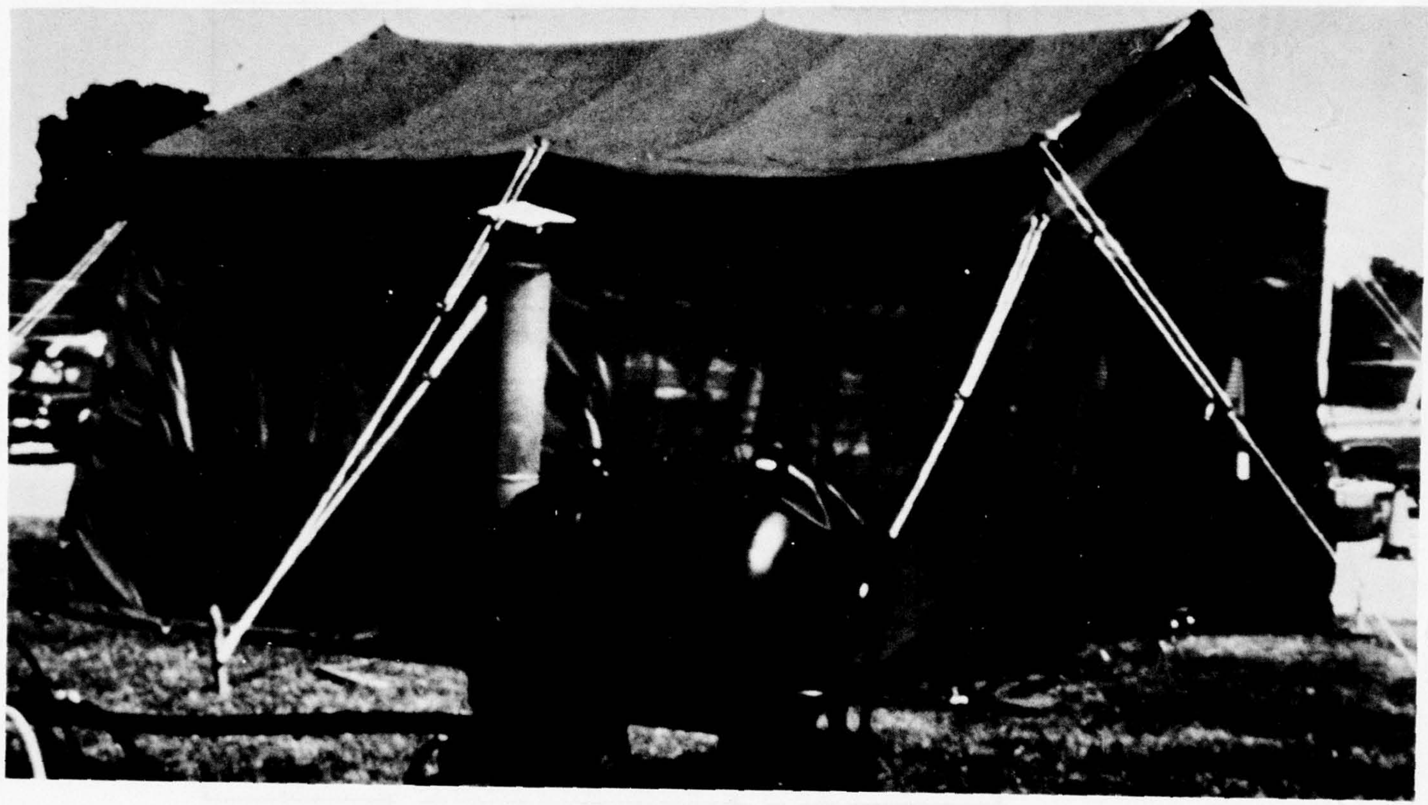

Figure 5. EXTERIOR VIEW OF XM-75 SANITATION CENTER

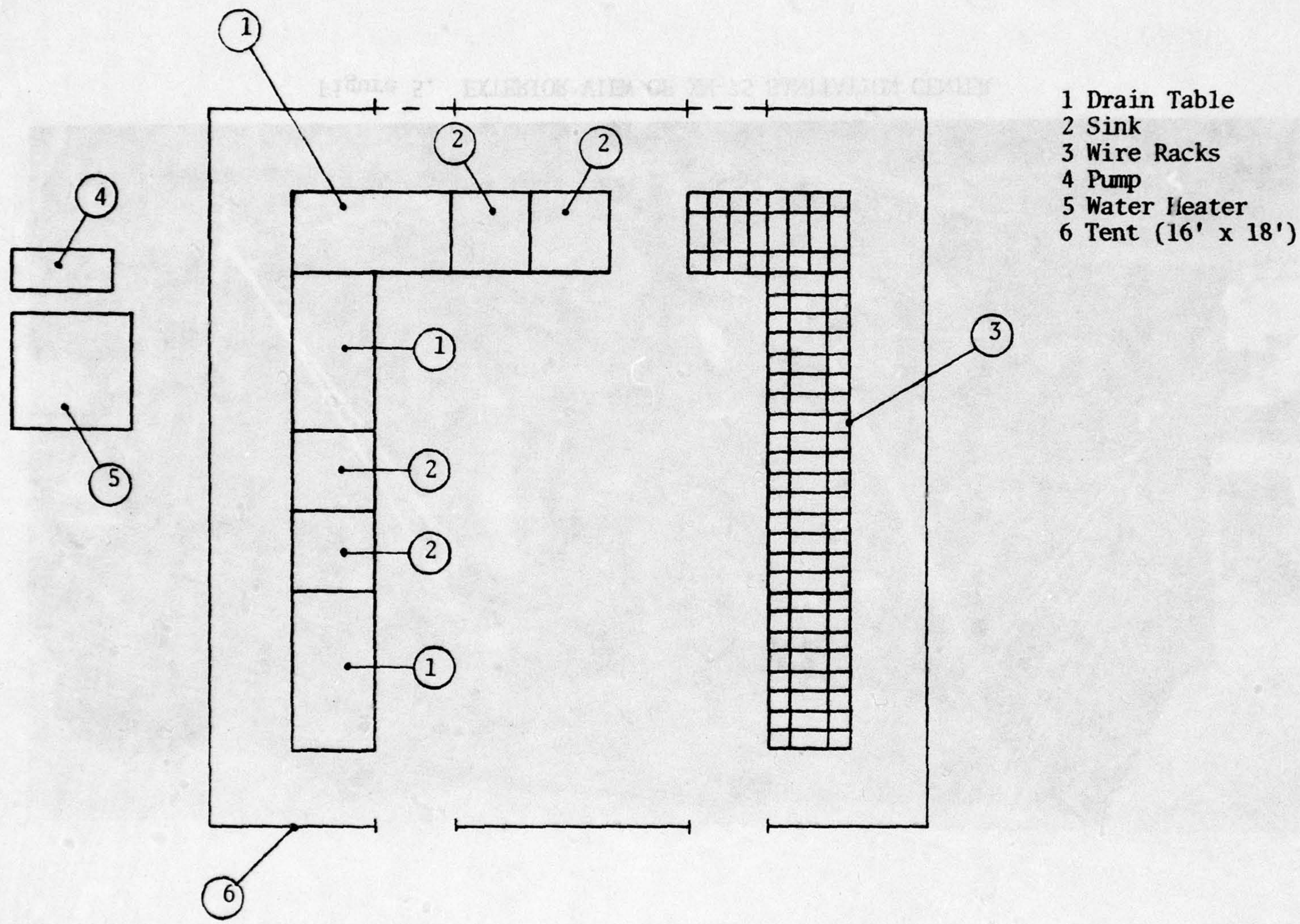

Figure 6. LAYOUT OF XM-75 SANITATION CENTER

Multiple MKT configurations have been designed for field hospital food service operations.

The XM-75 sanitation center is to be employed with all MKT systems.

WARD DELIVERY OPTIONS

Three ward delivery options, including the standard insulated food container, were considered for possible use with these systems.

a. Insulated Trays. Commercial insulated trays contain two main dish compartments, two side dish compartments, and one large rectangular compartment for utensils, beverages, napkin, etc. Either permanent or disposable (dishware) inserts and beverage containers may be used. All meal components, hot and cold, are portioned directly into individual inserts or containers placed on the base of each tray. The cover is placed on each tray after it is completely assembled. Each compartment is insulated and separated from the others to maintain food temperatures. Once assembled the completed trays are stacked and strapped in groups of five. One person can transport ten trays from the kitchen to the ward. Ward personnel need only to issue the trays to the patients. Beverages are delivered in bulk beverage containers.

b. Portable Serving Line. The portable serving line consists of an insulated base and cover. The base contains four wells, designed to hold two each 1/3 size steam-table pans, 6" deep, with covers. Each well is insulated and separated from the others, thus hot items and cold items may be placed next to each other. Space is also provided for serving utensils required to serve the meal. Regular meals are bulk portioned into the steam-table pans, and special diet foods are individually portioned into disposable containers which are placed in steam-table pans or directly in the wells of the serving line. Beverages are transported to the ward in bulk beverage containers. The portable serving line is carried by two people, in the same fashion as a litter.

c. Insulated Food Containers. Field medical units are currently authorized the standard insulated food container. The insulated food container holds three inserts with lids, and may be used to transport either hot or cold items, but not both, since the inserts are not separated and insulated from each other. Therefore, hot and cold items must be delivered in separate containers. Regular diets are bulk portioned directly into the insulated food container inserts. Special diet items are individually portioned into a variety of disposable containers, and then placed in an insert. Usually, one insert is also required for serving utensils.

Figure 7. EXTERIOR VIEW OF ERECTED MKT

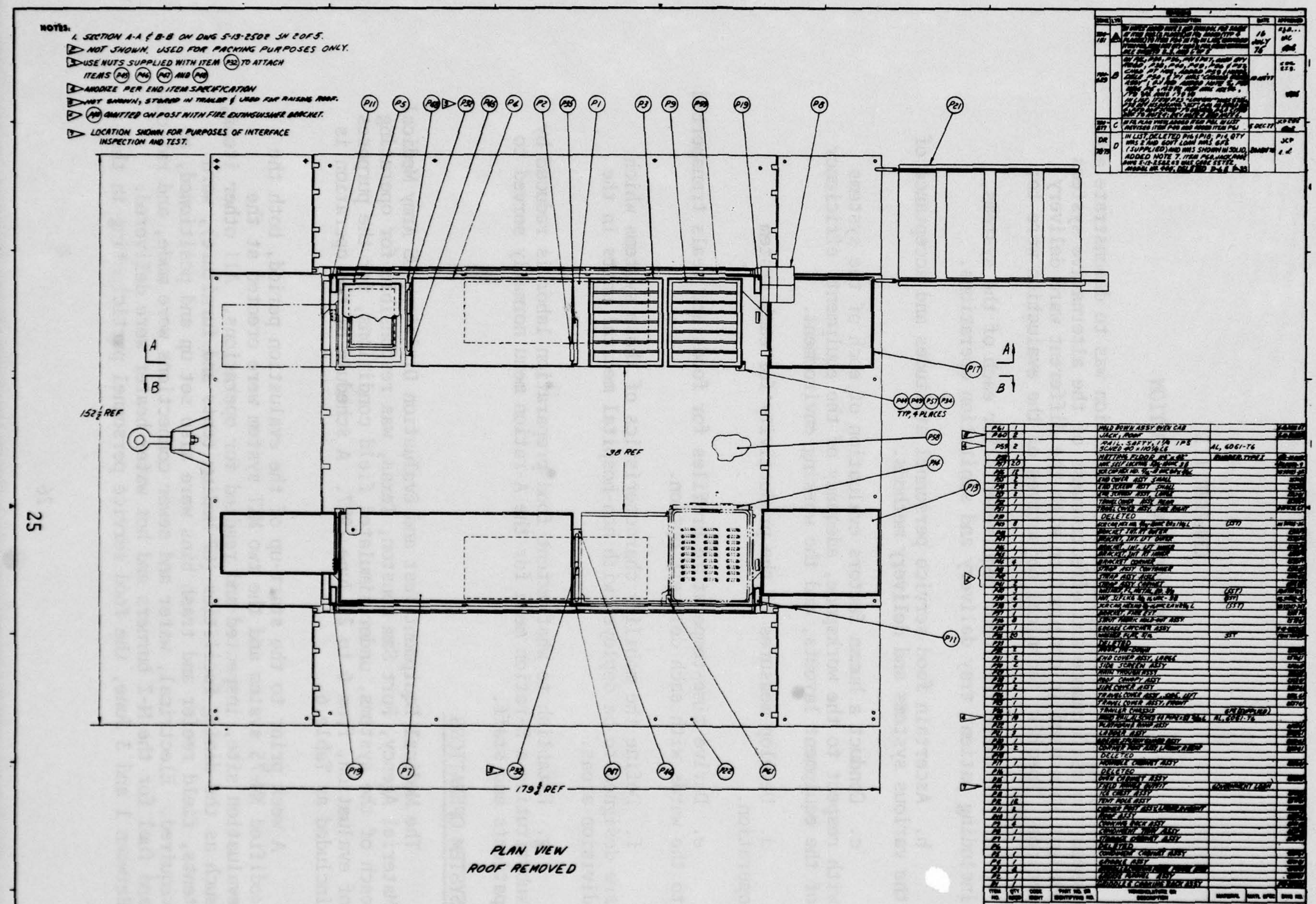

Figure 8. LAYOUT OF MKT

CHAPTER III

OPERATIONAL EVALUATION

The purpose of the operational evaluation was to demonstrate and assess the performance and effectiveness of the alternative systems designs when used in conjunction with the different ward delivery options. Specific technical objectives of the evaluation were to:

a. Estimate the labor requirements for each of the systems, including patient tray delivery and sanitation operations.

b. Ascertain food service personnel attitudes and acceptance of the various systems and delivery methods.

c. Conduct a human factors evaluation of each of the systems with respect to the workspace, adequacy of the equipment, efficiency of the equipment layouts, and the working environment.

d. Develop measures of the productivity for each system operation.

e. Derive time-temperature profiles for foods and meals transported to the wards with each delivery option.

f. Define the mobility characteristics of those systems which are designed to be deployed with non-hospital medical units in the division areas.

g. Establish to what extent food preparation labor is reduced by substituting a B-ration menu for the A-ration menu normally served to patients and staff.

SYSTEM OPERATIONS

The Medical Equipment Test and Evaluation Division, US Army Medical Materiel Agency, Fort Sam Houston, Texas, was responsible for operating each of the systems, under simulated field conditions, for the purposes of evaluation, from 6 to 23 June 1977. A schedule of the operation is included as Table 6.

A week prior to the start-up of the evaluation period, both the modified XM-75 system and the two MKT system were erected at the evaluation site, inspected and readied for operations. All other items, such as the dining facilities (GP Medium tents and furniture), ward tents, field reefer and trash bins were also set up and positioned, as required. Electrical, water and sewer connections were made, and rations and fuel for the M-2 burners and hot water heater were delivered. Between 1 and 3 June, the food service personnel participating in the

TABLE 6

SCHEDULE OF OPERATIONS

	6-11 June	12-17 June	18-23 June
SYSTEMS	Modified XM-75	Two MKT System	Reduced XM-75 Single MKT
DELIVERY OPTION[a]	Portable Serving Line w/Disposables	Insulated Container w/Disposables	---
	Insulated Trays w/Permanent Inserts	Insulated Trays w/Disposable Inserts	---
MENUS[b]	A-ration	A-ration	A-ration
	B-ration	B-ration	---
DINNERWARE	Disposables	Disposables	Disposables
WARDS	Two	Two	---
PATIENT MEALS[c] PER WARD	Fifteen Regular Diets Five Special Diets (Either Liquid or Dental Soft)	Fifteen Regular Diets Five Special Diets (Either Liquid or Dental Soft)	---

[a] Each option used for three consecutive days.

[b] B-ration menu, with fresh salads and milk, served one day.

[c] Equal number of liquid and dental soft diet meals served.

30

evaluation were familiarized with the systems and equipment, and were provided three days of training and hands-on experience in their operation by a food service team from the US Army Quartermaster School, Fort Lee, Virginia.

During the initial phase of the evaluation, the modified XM-75 was operated consistent with Combat Support Hospital food service requirements, using, first, the portable serving line for ward delivery, and then insulated trays for the remainder of the time. An A-ration menu was offered at three meals daily, except for one day when a B-ration was served. The equivalent of forty meals, including ten liquid and dental soft diets, were prepared, assembled and delivered to two separate wards at each meal period. In the subsequent phase of the evaluation, the two MKT system was operated in exactly the same manner, except that the insulated container and insulated trays, with disposables, were alternated as the ward delivery options. For the final phase of the evaluation, these two systems were converted to reduced XM-75 and single MKT operations, as would be required for non-hospital medical units in the division area. Each served an A-ration menu three times a day on disposable dinnerware. Patient food service was not provided.

A garrison dining hall near the evaluation site was inactivated, and the troops eating there were assigned to the field dining facilities to represent the medical staff and patients. Military food service personnel from the dining hall were used to operate the systems, which were staffed according to the appropriate TOE authorizations. There was a sufficient number of personnel to permit using a two-shift, rotating schedule and avoid working anyone excessively long hours. The civilian food service workers from the dining hall performed the KP functions in the systems operations, but their schedules were consistent with their normal work routines. Generally, three food service workers were required every day. Personnel from the 41st Combat Support Hospital were detailed for serving on the wards at mealtimes, two per ward.

DATA COLLECTION

A variety of data were obtained from the operational evaluation which provide the basis for subsequent analysis and comparison of the alternative system designs and ward delivery options. Certain of the data were collected relative to all systems, including:

a. Work Measurement data which was used to calculate workloads and labor requirements.

b. Acceptance data from the participating food service personnel reflecting attitudes, likes and dislikes and other relevant information regarding the systems operations.

c. Human factors data relating to the physical characteristics of the systems, such as workspace, equipment and the working environment.

d. Headcount data for developing estimates of productivity.

e. Food temperature data to construct time-temperature profiles for the ward delivery option.

Other data and information specific to a particular system, e.g., mobility characteristics of the reduced XM-75, or pertaining to non-systems issues, e.g., effect of type of ration on labor requirements, were also acquired during the evaluations.

COMPARISON OF MODIFIED XM-75 AND TWO MKT SYSTEMS

Data from the operational evaluation of the modified XM-75 system and the two MKT systems were analyzed and compared to determine the preferred alternative for the Combat Support Hospital.

a. Work Measurement. Work sampling methods were employed to obtain the necessary data to characterize the workloads associated with operating the two systems. Observations were made at approximately ten minute intervals on every individual in the working situation, starting with the preparation of breakfast through cleanup after the dinner meal, from about 0400 to 1900 hours each day. Baking, which was scheduled at night, was not included in the work sample. These observations were classified and recorded by worker and task category. About 1200 observations were collected for each of the three days from the modified XM-75 system, and for four days from the two MKT system.

The average number of observations per day in a worker/task category were calculated for each system, then divided by six to yield an estimate of the man-hours expended daily on that task. The results, excluding ward patient feeding activities which are treated separately in Chapter IV, are summarized in Table 7. The differences between the total workloads of 99.02 productive man-hours for the modified XM-75 system, and 102.20 productive man-hours for the two MKT system, accurate to within 2% of their absolute values at a 95% confidence level, are not statistically or practically significant.

TABLE 7

AVERAGE NUMBER MAN-HOURS EXPENDED DAILY

Task	Modified XM-75 System: Food Service MOS	Modified XM-75 System: KP	Modified XM-75 System: Total	Two MKT System: Food Service MOS	Two MKT System: KP	Two MKT System: Total
Food Preparation	31.83	1.33	33.16	36.25	1.12	37.37
Baking	0.17	0.00	0.17	0.00	0.00	0.00
Serving	17.72	0.17	17.89	16.92	0.08	17.00
Kitchen Sanitation	7.39	1.44	8.83	7.17	0.92	8.09
Pot/Pan Sanitation	1.17	12.22	13.39	0.21	11.58	11.79
M-2 Burners	9.50	0.00	9.50	11.87	0.00	11.87
Other Productive Activity	14.62	1.45	16.07	14.62	1.45	16.07
Productive Man-Hours	82.40	16.61	99.01	87.04	15.15	102.19
Nonproductive Man-Hours	80.72	17.39	98.11	89.21	18.79	108.00

As expected, preparing and serving food and cleaning the kitchen area and equipment constituted the major workload of the food service personnel, and sanitation of cooking and serving utensils comprised 75% of the KP productive efforts. Also, a substantial portion of time was necessary for cleaning, fueling, lighting and maintaining the M-2 burners. Other productive activities, e.g., supervision and handling and storing supplies, are not directly related to, or dependent on, system factors. Thus, the total man-hours expended for such purposes were equally apportioned to the systems in determining workload.

Perhaps the most important finding of the work measurement analysis is that about 50% of the available man-hours were nonproductive time, including meal periods and scheduled breaks. Therefore, the distributions of productive efforts by hour of the work day, shown in Figures 9 and 10, were next examined. These data indicate that, on the average, no more than eight productive man-hours of food service personnel time, and a maximum of two hours of KP time were required at any hour of the day. This suggests that, if they are to be scheduled to work the entire day in field or combat conditions, the current TOE may be substantially reduced with either of the alternative system designs. Otherwise, the personnel may be scheduled for shorter intervals of work. In either case, the unnecessary, nonproductive time could be considerably reduced.

A B-ration menu was served for one day in each system operation, with A-ration meals being offered on all of the other days. The work sampling data were pooled, since the system workloads are essentially the same, and reduced so that the effects of type of ration on labor requirements, principally food preparation times, could be analyzed. The results, Table 8, show virtually no difference, within the precision of the data, in the average man-hours expended daily for food preparation as a function of the ration, and are only slightly different with respect to total productive man-hours.

TABLE 8

LABOR REQUIREMENTS FOR

A-RATION AND B-RATION

Tasks	A-Ration	B-Ration
Food Preparation	36.03	34.42
Other Productive Activities	66.67	61.74
Total Productive Man-Hours	102.70	96.16

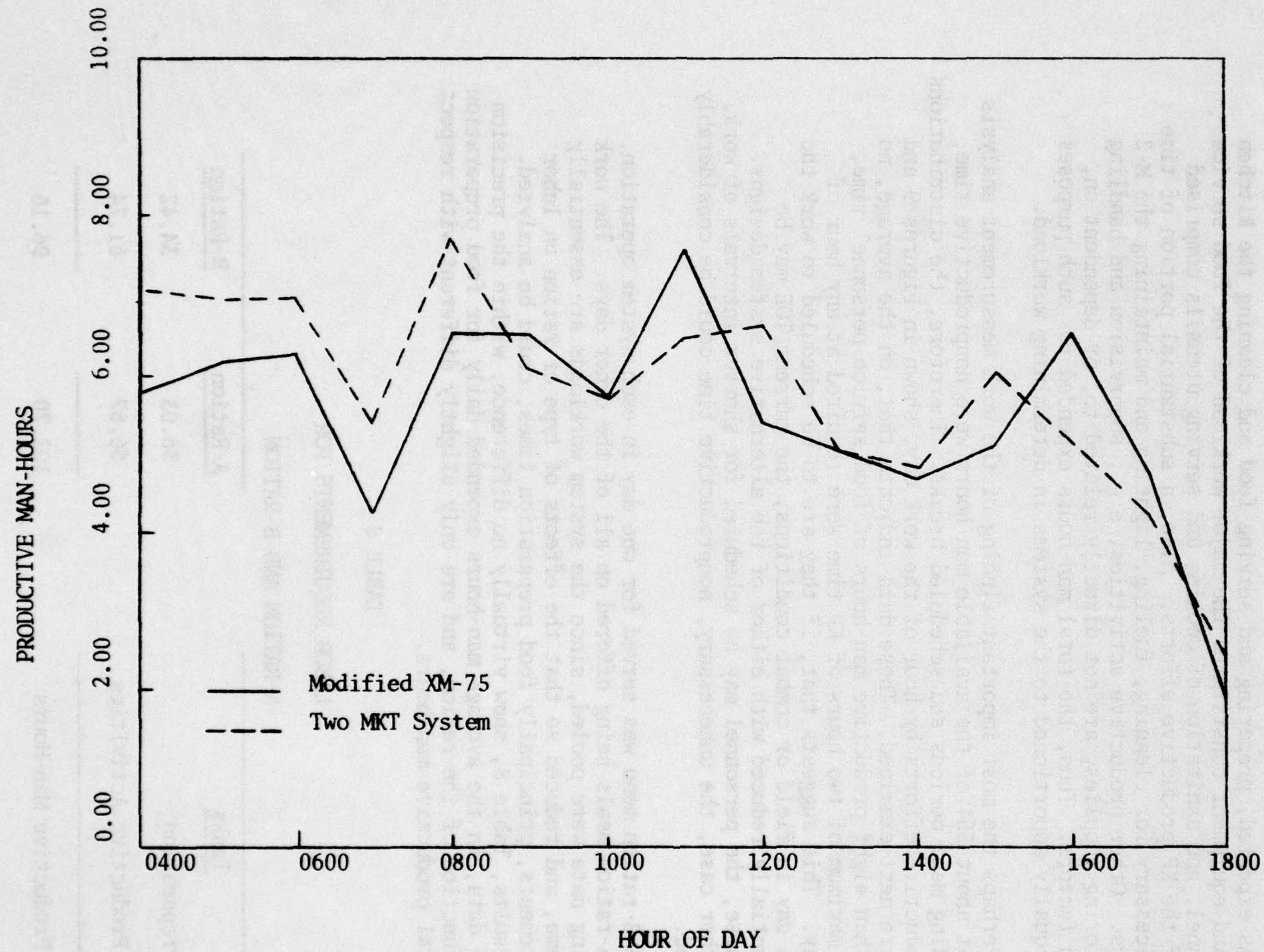

Figure 9. DISTRIBUTION OF PRODUCTIVE TIME FOR FOOD SERVICE PERSONNEL

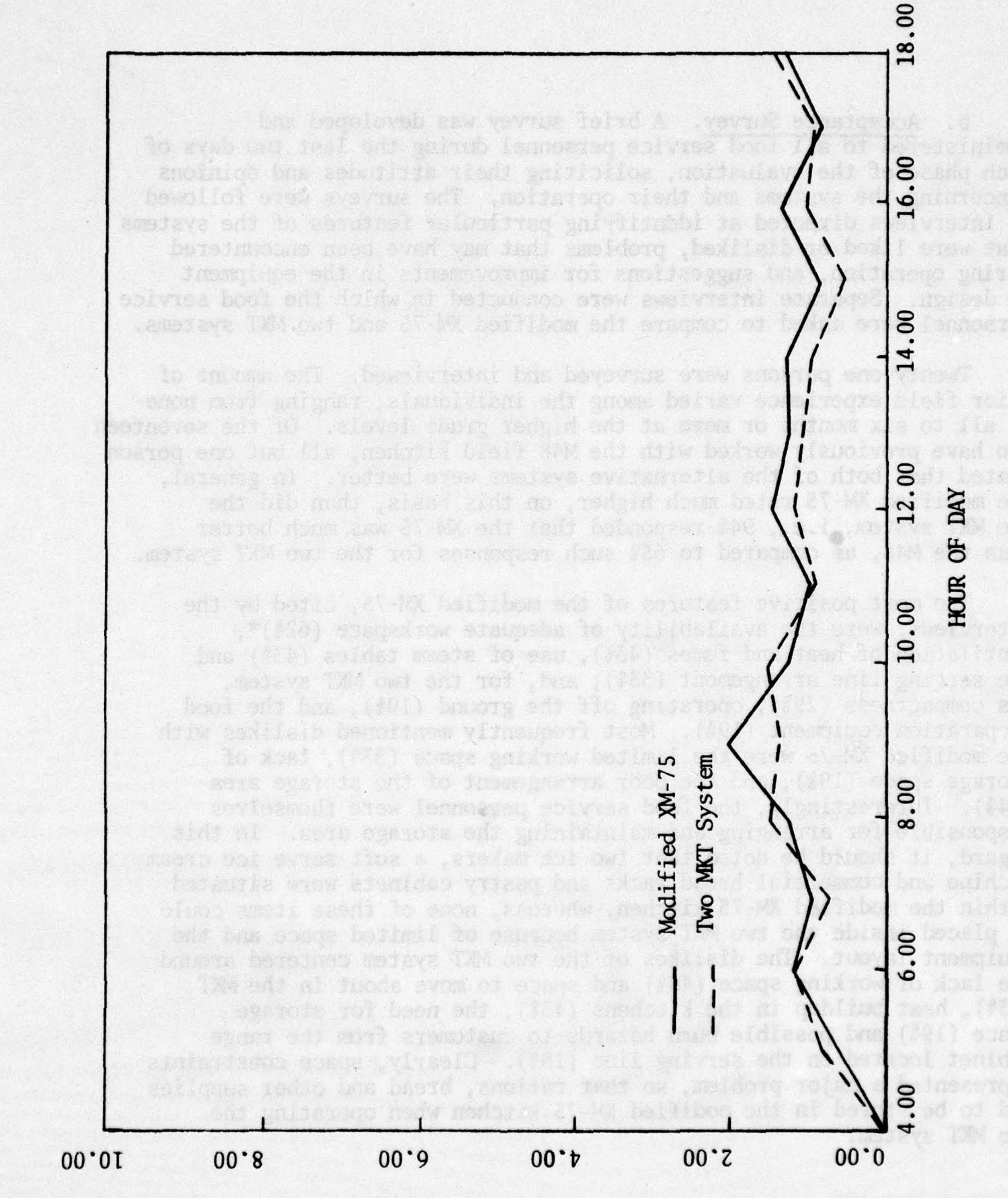

Figure 10. DISTRIBUTION OF PRODUCTIVE TIME FOR KP PERSONNEL

b. Acceptance Survey. A brief survey was developed and administered to all food service personnel during the last two days of each phase of the evaluation, soliciting their attitudes and opinions concerning the systems and their operation. The surveys were followed by interviews directed at identifying particular features of the systems that were liked or disliked, problems that may have been encountered during operation, and suggestions for improvements in the equipment or design. Separate interviews were conducted in which the food service personnel were asked to compare the modified XM-75 and two MKT systems.

Twenty-one persons were surveyed and interviewed. The amount of prior field experience varied among the individuals, ranging from none at all to six months or more at the higher grade levels. Of the seventeen who have previously worked with the M48 field kitchen, all but one person stated that both of the alternative systems were better. In general, the modified XM-75 rated much higher, on this basis, than did the two MKT system, i.e., 94% responded that the XM-75 was much better than the M48, as compared to 65% such responses for the two MKT system.

The most positive features of the modified XM-75, cited by the interviews, were the availability of adequate workspace (62%)*, ventilation of heat and fumes (43%), use of steam tables (43%) and the serving line arrangement (33%); and, for the two MKT system, its compactness (29%), operating off the ground (19%), and the food preparation equipment (19%). Most frequently mentioned dislikes with the modified XM-75 were the limited working space (33%), lack of storage space (19%), and the poor arrangement of the storage area (14%). Interestingly, the food service personnel were themselves responsible for arranging and maintaining the storage area. In this regard, it should be noted that two ice makers, a soft-serve ice cream machine and commercial bread racks and pastry cabinets were situated within the modified XM-75 kitchen, whereas, none of these items could be placed inside the two MKT system because of limited space and the equipment layout. The dislikes of the two MKT system centered around the lack of working space (48%) and space to move about in the MKT (43%), heat buildup in the kitchens (43%), the need for storage space (19%) and possible burn hazards to customers from the range cabinet located on the serving line (19%). Clearly, space constraints represented a major problem, so that rations, bread and other supplies had to be stored in the modified XM-75 kitchen when operating the two MKT system.

---

*Percent of people interviewed responding in this manner.

Mean ratings of the systems characteristics from the surveys are presented in Table 9. Each characteristic was rated on a seven point scale from 1 (Very Bad) to 4 (Neither Good or Bad) to 7 (Very Good). Those factors which best differentiate between the two systems, statistically significant at the 1% confidence level, are size of the kitchens, limited space for moving about, ease of serving customers, and safety. Overall, these data are consistent with the results of the interviews.

In comparing the total systems, ten of the twenty-one food service personnel preferred the modified XM-75, while the preference of six people was for the two MKT system, and five indicated no preference between the two alternatives. Again, the difference in preferences is statistically significant at the 1% confidence level.

c. <u>Human Factors</u>. Samples of wet and dry bulb temperatures were taken several times daily in both systems with a battery powered thermistor psychrometer. All readings were recorded under fair weather conditions. A summary of the maximum waist level temperatures from each sample is contained in Table 10. Effective is an empirical thermal index defined as the subjective feeling of warmth based upon dry and wet bulb temperature measurements and air movement. The maximum acceptable effective temperature for prolonged periods of exposure is specified as 85°F.[4] Maximum waist level temperatures dry-bulb in the two MKT system averaged 6.5°F (above ambient) higher than in the modified XM-75 kitchen; about 3°F (above ambient) in effective temperature. Groin level temperatures at the griddle ranged from 85.5°F to 102.0°F in the modified XM-75, and from 99.0°F to over 190.0°F in the two MKT system. These temperature differentials, which would be expected to increase significantly when the shelters are secured against foul weather conditions, may be assigned to more effective ventilation and exhaust stacks and heat shields installed on the grills in the modified XM-75 system.

---

[4] Military Standard, MIL-STD-1472B, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities", 31 December 1974.

TABLE 9

MEAN RATINGS OF SYSTEM CHARACTERISTICS

	Modified XM-75	Two MKT System
Size of kitchen	5.76	3.81
Limited space for moving about	4.25	2.48
Ease of serving customers	6.67	5.19
Safety	5.11	3.71
Ease of meal preparation	5.76	4.71
Smoke and steam	6.00	5.05
Noise	6.25	5.52
Amount storage space	4.86	4.14
Space for filling and assembling ward delivery options	4.50	3.90
Temperature	3.57	3.05
Sanitation	6.00	5.62
Ease of cleaning	6.19	5.86
Accessibility to supplies stored in kitchen	4.81	4.48
Insect control	4.80	4.48
Lighting	6.40	6.19

TABLE 10

MAXIMUM WAIST LEVEL TEMPERATURES

		Modified XM-75	Two MKT System
Dry Bulb Temperature (^{o}F)	Absolute	92.6	95.1
	Above Ambient	5.2	11.7
Effective Temperature (^{o}F)	Absolute	84.6	85.8
	Above Ambient	3.2	6.1

The two MKT configuration with the straight serving line provided only four cooking racks for serving hot items. When a griddle was required on the serving line, it occupied two of the racks, and it was necessary to add two squareheads with insulated food container inserts for serving hot components of a meal. This proved to be highly inefficient. The tall, narrow inserts are difficult to serve from, and had to be refilled frequently. Further, this arrangement allowed only two food service personnel to serve at a time. As a result, the average serving rate, discussed in paragraph e., was only 3.6 persons a minute, approximately 30% less than was experienced with the modified XM-75 system.

The only usable space in the MKT is a 38" center aisle, which provides slightly less than 100 square feet of floor space for food preparation and serving. It became so crowded on some occasions, especially during serving periods, that much of the food preparation work was done outside of the kitchen. Although this was possible during the operational evaluation, because of the fair weather conditions, it would be impractical in inclement weather. Such problems are less likely to occur in the modified XM-75, which has about 300 square feet, or nearly three times as much, usable floor space. In addition, one complete section at the rear of the XM-75 shelter was allocated to storing rations and supplies. Except for a few small cabinets, virtually no storage space of any kind is available in the MKT.

The stairs associated with the MKT appear to be a distinct disadvantage in a Combat Support Hospital application, reducing the number of semiambulatory patients able to go through the serving line, thereby increasing feeding levels on the wards, which is labor intensive.

d. Productivity. Detailed headcount data, numbers of meals served, for those days corresponding to the work sampling period are provided in Table 11. The reduced headcounts experienced with the two MKT system resulted, in part, from variations in the number of Army Reserve troops on summer training at Fort Sam Houston assigned to the field dining facilities.

Productivities of the systems, meals served per productive man-hour expended, are shown in Table 12. Only those meals served in the dining facilities are considered, as ward patient feeding is analyzed in Chapter IV. Since the same personnel operated both of the systems, it may reasonably be concluded that the somewhat higher productivity rates attained with the modified XM-75 can be attributed to the efficiency of the system design.

TABLE 12

SYSTEM PRODUCTIVITY

System	Average Number[a] Meals Per Day	Average Number[b] Man-Hours	Productivity Meals/Man-Hour
Modified XM-75	1011	99.02	10.2
Two MKT System	887	102.20	8.8

[a]Calculated from Table 11.

[b]Total productive man-hours, from Table 7.

e. Serving Rates. These data were collected only at those times a waiting line existed, which would otherwise be a function of customer arrivals rather than a measure of system performance. Similarly, the data apply just to lunch and dinner meals. At breakfast, when items are prepared to order, the rate of service is more dependent on the ability of the cooks than the system design and/or capacity. A total of 163 minutes of waiting lines were observed during operation of the modified XM-75 system, at which times 793 customers were served. This gives a serving rate of 4.7 persons per minute. Waiting lines times recorded during the two MKT system operations amounted to 178 minutes, with 644 customers served, for a serving rate of 3.6 persons per minute, about 30% less than for the modified XM-75.

TABLE 11

HEADCOUNT DATA

System	Date	BREAKFAST				LUNCH				DINNER			
		Dining Facility	Ward Regular	Ward Special	Total	Dining Facility	Ward Regular	Ward Special	Total	Dining Facility	Ward Regular	Ward Special	Total
Modified XM-75	7 June	-	-	-	-	-	-	-	-	383	15	10	408
	8 June	263	30	10	303	364	30	10	404	288	30	10	328
	9 June	277	23	0	300	292	30	10	332	345	30	10	385
	10 June	237	26	10	273	260	28	10	298	-	-	-	-
	Average	259	26	7	292	305	29	10	345	339	25	10	374
Two MKT System	13 June	-	-	-	-	-	-	-	-	289	30	10	329
	14 June	270	30	0	300	290	30	10	330	318	30	10	358
	15 June	246	30	10	286	259	30	10	299	250	30	10	290
	16 June	222	15	10	247	233	30	10	273	299	36	10	345
	17 June	231	20	10	261	197	20	10	227	-	-	-	-
	Average	242	24	8	274	245	38	10	282	289	32	10	331

COMPARISON OF REDUCED XM-75 AND SINGLE MKT SYSTEMS

The data compiled in the final phase of the evaluation involving the reduced XM-75 and single MKT systems were analyzed and compared to determine the preferred alternative for non-hospital medical units. Because of the similarities with the modified XM-75 and two MKT system, all aspects of the evaluation were not repeated in entirety.

a. Work Measurement. Since both of the systems were operated simultaneously, it was expedient to perform certain of the tasks jointly --- beverage preparation, KP functions, primarily pot and pan sanitation and maintenance of the M-2 burners --- rather than completely duplicate all of the efforts. Thus, these labor requirements were charged, as with the category of other productive activities, evenly to each of the systems.

Three days of work sampling data were collected; over 600 observations a day for each system operation. The results, converted to average number of man-hours expended daily are provided in Table 13, Differences in the task times and the total workloads for the reduced XM-75, 47.79 productive man-hours, and the single MKT system, 42.58 productive man-hours, are not statistically significant. Not unlike the results of the work measurement analysis in the previous section of this chapter, 50% of available man-hours are nonproductive time, implying possible staffing reduction or, at least, changes in scheduling policies.

It was not practical to maintain separate headcounts for each of the systems operations. But, an attempt was made to balance the number of customers served by each system at any given meal. Under these conditions, productivity and serving rates could not be explicitly evaluated. However, there were no noticeable differences observed, in these respects, between the two systems.

b. Acceptance Survey. Twelve food service personnel were interviewed on the final day of evaluation to compare the two alternatives. Ten of the twelve responses showed a decided preference for the reduced XM-75 system. The unanimous reason given for this was the greater amount of space provided as compared to the MKT. Other reasons stated were that it is easier to work in and to clean, has a better serving line, and has no stairs. The one person preferring the single MKT system did so because it was off the ground and mobile. One individual indicated no preference for either system.

TABLE 13

AVERAGE NUMBER MAN-HOURS EXPENDED DAILY

Task	Reduced XM-75 System Food Service MOS	Reduced XM-75 System KP	Reduced XM-75 System Total	Single MKT System Food Service MOS	Single MKT System KP	Single MKT System Total
Food Preparation	21.08	0.61	21.69	20.01	0.61	20.62
Beverage Preparation	4.52	0.00	4.52	4.52	0.00	4.52
Serving	11.34	0.00	11.34	9.17	0.00	9.17
Kitchen Sanitation	3.88	0.06	3.94	1.91	0.06	1.97
Pot/Pan Sanitation	0.00	6.50	6.50	0.00	6.50	6.50
M-2 Burners	4.76	0.00	4.76	4.76	0.00	4.76
Other Productive Activity	2.21	0.83	3.04	2.21	0.83	3.04
Productive Man-Hours	47.79	8.00	55.79	42.58	8.00	50.58
Nonproductive Man-Hours	42.21	8.00	50.21	47.42	8.00	55.42

c. Mobility. One of the most critical performance requirements of the food service system in support of the smaller medical units in the divisional area is mobility. The MKT is a completely self-contained unit, and inherently mobile, by design. The mobility characteristics of the reduced XM-75, however, had yet to be demonstrated and evaluated. A brief exercise was conducted as a part of the operational evaluation to provide this kind of information.

Six non-food service personnel from the 41st Combat Support Hospital participated in this exercise. None were familiar with the frame-supported shelter or food service equipment. The system, less the sanitation center, was loaded onto a 2½-ton truck and transported to a remote site, where it was offloaded, set up, taken down, and loaded back onto the truck. Detailed instruction were provided during the process on how to erect and strike the shelter, and how to arrange the various items of equipment within the shelter. This one cycle, which was essentially for training purposes, even with interruptions to give the necessary instructions, took approximately 50 minutes to set up, and 30 minutes to strike the system.

Following this practice cycle, the truck returned to the evaluation site, where the reduced XM-75 was set up one final time, and detailed working sampling data were collected. The entire reduced XM-75 was offloaded from the truck, assembled, positioned, and completely set up, including staking and tying down of the shelter, in just 38 minutes. The shelter alone, without being staked or tied, or the side and end panels becketed together, was standing with fabric after only 16 minutes.

The level of effort required, based on an analysis of the work sampling data, is described in Table 14. The 56 man-minutes of the nonproductive time occurred because, on initial cycle, a part of the troops were trained on the shelter and the others on the equipment but not both. It is expected that additional experience and cross-training on all elements of the system would decrease the level of effort somewhat, and reduced the actual time needed for offloading and set up to something under half an hour.

TABLE 14

RESULTS OF MOBILITY EXERCISE

REDUCED XM-75 SYSTEM

Task	Man-Minutes
Offload all equipment	22
Assemble and position equipment (less the shelter)	52
Assemble, erect, becket, position stake and tie down shelter	98
Productive Time	176
Nonproductive Time	56

RESULTS AND CONCLUSIONS

Based on the foregoing analysis and comparison of data from the operational evaluation, it was determined that the modified XM-75 system was the more effective, and therefore the preferred food service system recommended for the Combat Support Hospital.

a. Work measurement revealed no significant differences in the total workloads, and only minor variations in the labor intensity, that is, the average number of productive man-hours expended daily, on the various tasks performed during the systems operations. These results, however, must be interpreted relative to the demands for service that were imposed upon each of the two systems. On the average, about 125 meals per day more were served from the modified XM-75 system than the two MKT system; the productivity rate of the former being about 15% higher. Both systems were operated by the same food service personnel, hence the greater productivity is attributed to the more efficient design of the modified XM-75.

b. The consensus of the food service personnel was a clear preference for the modified XM-75 system, as compared to the two MKT system, principally for the reasons that it provided more workspace, better ventilation, and a more suitable serving line and arrangement. A human factors evaluation subsequently confirmed the validity of these observations.

c. Sufficient space was available in the modified XM-75 kitchen shelter for it to contain bread racks, pastry cabinets, ice makers and a soft serve ice cream machine, in addition to all of the other equipment, and still provide for storage of nonperishable rations and supplies, none of which was possible with the two MKT system. Even with the added equipment, rations and supplies, there was nearly three times as much usable floor space for food preparation and serving as in the two MKT system. Lack of space caused considerable crowding and interference among personnel working in the two MKT system, so much so, that some of the food preparation was done on work tables, on the ground, outside the kitchen as a matter of convenience. The requirements of preparing meals for delivery to ward patients made the situation even more difficult.

d. Differences in the serving rates for the two systems, which were 30% higher in the modified XM-75 system, reflected the opinions expressed by the food service personnel. The size of the serving line on the two MKT system is inadequate to serve an A-ration menu for the headcounts experienced, if a grill is needed during the meal. Use of inserts from an insulated container to expand the capacity of the serving line, in this case, tends to further restrict the rate of service.

In summary, the modified XM-75 kitchen represents a considerable improvement over the standard M48 kitchen. The frame supported shelter offers substantially greater unencumbered space, allowing for more flexible and efficient layout of equipment and workspace, and generally, providing for better working conditions. All new food equipment items functioned quite satisfactorily during the evaluation, and were highly acceptable to the operating food service personnel. Likewise, inclusion of the sanitation center significantly contributed to the higher effectiveness and acceptability of the XM-75 system. However, observations during the evaluation has suggested other additional design improvements to this component of the system:

a. Larger outlets are needed for more rapid draining of water from the sinks. Also, a strainer should be installed over the outlets to trap garbage and other materials that may plug or reduce the flow of the drain lines.

b. A wire basket should be made available to wash or rinse several small untensils at one time.

c. The commercially available open wire shelving used for drying and storing pots, pans and utensils was not entirely satisfactory. Assembly and disassembly of the shelving was troublesome and time consuming, and if needed to be done frequently, the durability of rigid wire components is suspect. Further, since there are no backs to the shelves, if items being stored were not neatly stacked, things often tended to slide off the shelves onto the ground. Thus, shelving specifically designed for field use is required.

d. Solid faced white plastic pallets used as flooring in the sanitation center, also obtained from commercial sources, were considered far superior to the wooden pallets typically used for this purpose, but a darker color may be more desirable.

Neither the reduced XM-75 or the single MKT were conclusively demonstrated to be the more effective system for the smaller, non-hospital medical units as a result of the evaluation. Many of the differences and difficulties noted in comparing the modified XM-75 and two MKT system are considerably diminished at the reduced feeding levels. Although the data from the mobility exercise is somewhat limited, it does not appear that this aspect of the reduced XM-75 should preclude its suitability or acceptance in this application. Two factors argue for recommending the reduced XM-75 system as the preferred alternative. The first is that it was unquestionably the preferred choice of the food service personnel taking part in the operational evaluation. But, more importantly, this would provide for the commonality of food service systems in all field medical units and hospitals, thereby simplifying procurement, inventory, personnel training and other attendant problems and concerns.

The evaluation produced relevant information on two other matters of interest, although not specifically related to the question of choice of alternative systems. No apparent decrease in workload or labor requirements is obtained by substituting a B-ration for the A-ration menu. The argument offered for this result is that the different handling and preparation methods between the two rations are equally time-consuming and laborious. Finally, all of the systems operations were staffed by the current TOE authorized strengths for comparable sized units. Work measurement data disclosed that the assigned food service personnel were not being effectively utilized, resulting in unnecessary nonproductive time. Appropriate staffing requirements should be developed, if the recommended systems are adopted and implemented.

Detailed cost estimates for the XM-75 system equipment are included in Appendix A.

CHAPTER IV

WARD DELIVERY OPTIONS

Three ward delivery options for transporting regular and special diet meals from the field kitchen to the wards for feeding non-ambulatory patients were evaluated. These included two bulk delivery methods, a portable serving line and the standard insulated food container, and individual insulated trays. Only the concepts of operations with the portable serving line and with insulated trays were evaluated, and not the items themselves. If either of these concepts proved acceptable, then they would be designed and engineered to the exact requirements of the field medical units.

OPERATIONAL EVALUATION

The portable serving line and insulated trays were utilized with the modified XM-75 system. Because of its size and weight, the portable serving line could not be easily carried up and down the stairs of the MKT, so that insulated food containers and insulated trays were employed in the two MKT system operations.

a. Acceptance Survey. A survey was administered to the food service personnel to determine their preferences for the insulated trays, or portable serving line. No attempt was made to measure their preference for these two delivery options relative to the standard insulated food container. The responses are summarized in Table 15. Both diet and other cooks expressed a preference for the insulated trays in terms of number of responses and in terms of average rating.

During the evaluation, meals for only two wards were provided and delivered. This is equivalent to the ward feeding requirements for the smaller non-hospital medical units. If the number of meals increased to, about 100-200 meals, which would be typical for a Combat Support Hospital, it is anticipated that the preferences would shift toward a bulk delivery method, because of the increased workload imposed on the kitchen staff with the insulated trays, which is discussed later, paragraph c. below.

TABLE 15

FOOD SERVICE WORKER PREFERENCES BETWEEN

INSULATED TRAYS AND PORTABLE WARD SERVING LINE

Option	Rating Categories	Number of Respondents			
		Diet Cooks	Other Cooks	All Cooks	% Of Total
Insulated Trays	Much Better	2	5	7	41
	Somewhat Better	1	0	1	6
	Slightly Better	1	2	3	18
	Both the Same	0	2	2	12
Portable Serving Line	Slightly Better	1	0	1	6
	Somewhat Better	0	0	0	0
	Much Better	0	3	3	18

b. Time-Temperature Profiles. Time-temperature profiles were constructed for each of the three delivery options used in the evaluation, Figures 11 and 12. For insulated trays, the bulk food items were measured prior to being portioned onto disposable or permanent inserts, which were then placed in each tray and covered. This represented the initial temperature. A series of four or five trays were assembled for each meal included in the sample. After fifteen minutes of elapsed time, the first tray was opened and the temperatures recorded; after thirty minutes, the second tray; and so on, using a different tray corresponding to each time period. The portable serving line was filled directly from the serving line. The initial temperature was the temperature of the items on the serving line at the time of filling. After 15 minutes the portable serving line was opened, the temperatures recorded, and then closed. The process was repeated in fifteen minute intervals. The insulated food containers were preheated prior to being filled. The inserts were then filled and placed in the insulated food container. The initial temperature of the food in the insulated food container was measured prior to being closed. Then, as with the portable serving line, the container was opened, temperatures recorded, and then closed, every fifteen minutes.

Heat transfer (loss or gain) is a function of the density of the food products, the insulating characteristics of the container, and the temperature differential between the product and ambient environment. Therefore, to establish a common scale for all recorded temperatures, ambient temperature was subtracted from the product temperature, to obtain "^{o}F Above Ambient". The scaled values for each delivery option, at each time interval, were averaged to obtain the data for the time temperature profiles. As can be seen, food stored in the insulated trays cooled at a considerably faster rate than for either of the bulk delivery methods. With the insulated trays, large temperature drops, approximately 30^{o}F, occurred during the first fifteen minute interval to about 140^{o}F, the lower limit of desired serving temperatures. This is attributable to the heat loss during the portioning process, from the time the food was portioned until it was covered, and the fact that small quantities of food cool more rapidly than the larger quantities in the bulk containers. Both the bulk delivery subsystems maintained satisfactory temperature levels for extended periods of time; the insulated food container at higher temperatures than the portable serving line. This resulted for several reasons: the insulated food containers were preheated prior to use; the insulated container inserts tended to be full, (usually containing more than the fifteen portions required); less surface area was exposed in the insulated food containers, therefore less temperature loss when opened for measuring temperatures; and, because the insulated food containers were open for shorter periods of time than the portable serving line.

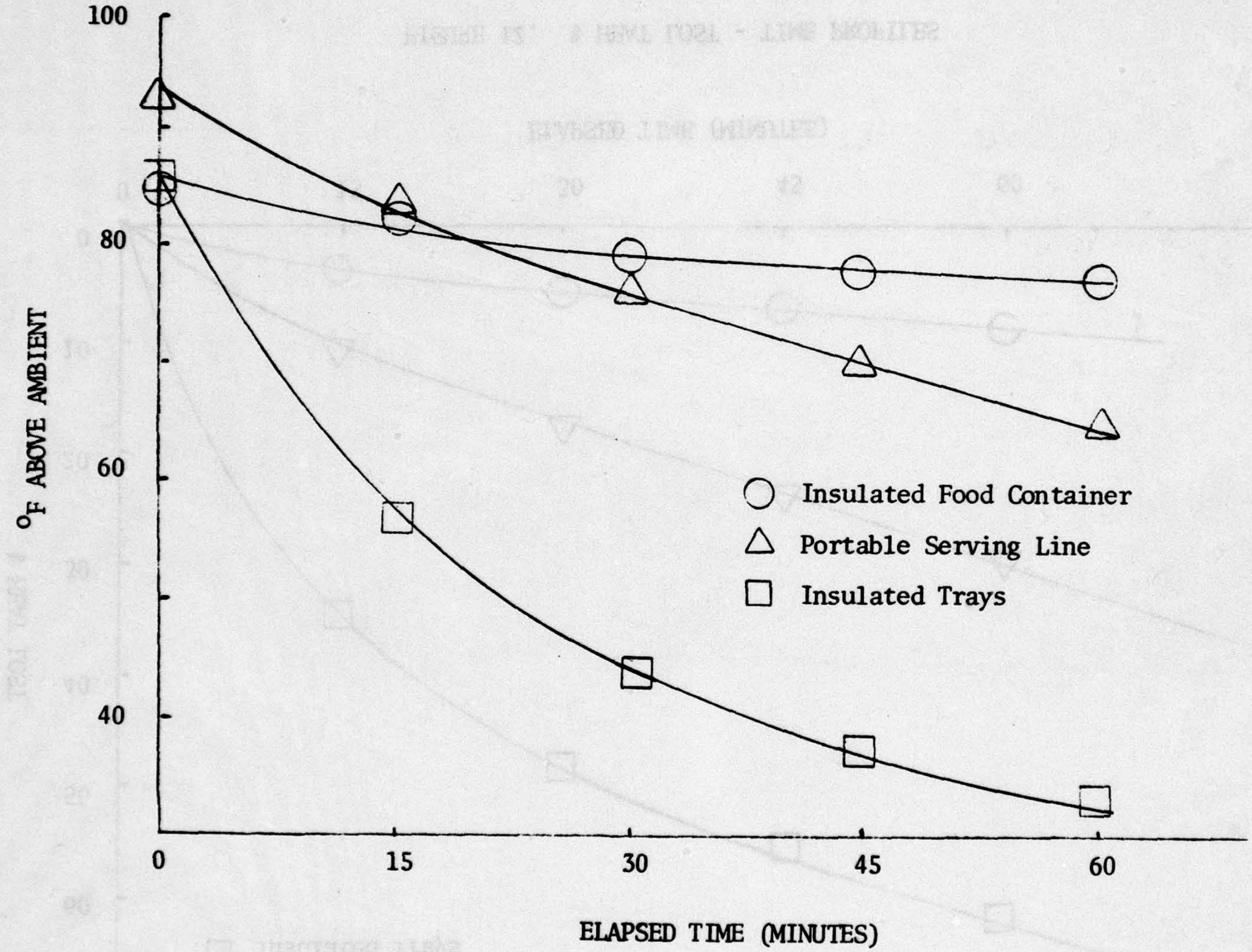

FIGURE 11. TIME-TEMPERATURE PROFILES

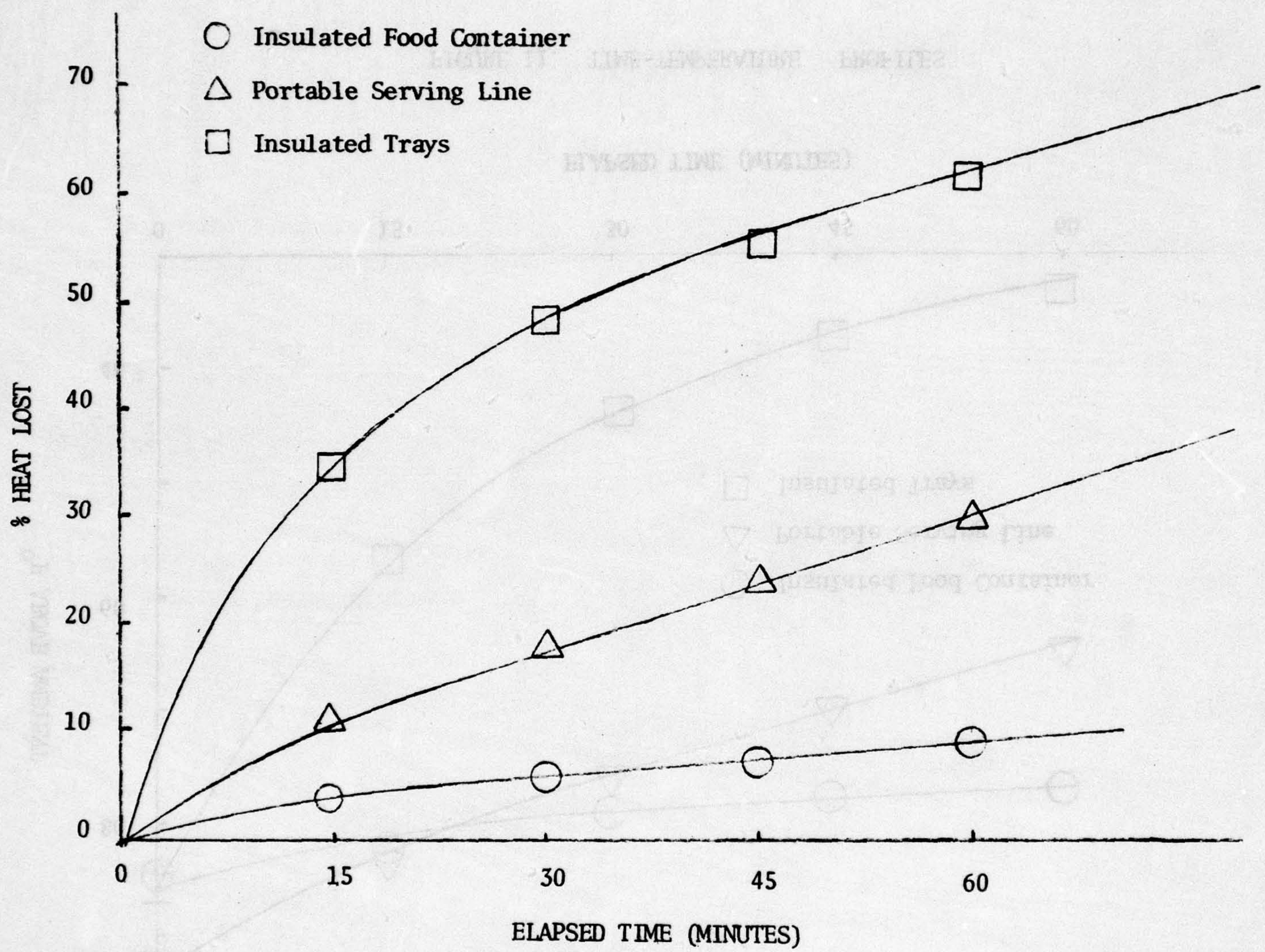

FIGURE 12. % HEAT LOST - TIME PROFILES

Figure 12 illustrates heat loss as a function of time for each ward delivery option. Approximately 35% of the heat has dissipated from the insulated trays after 15 minutes. After sixty minutes 30% heat was lost in the portable serving line, but only 9% from the insulated food container. Extrapolating these results out to two hours yields a total heat loss of 18% with the insulated food container. In this instance, the food would be 70°F above ambient, or 153°F; still an acceptable serving temperature after being held for two hours.

c. Work Measurement. Detailed work sampling data were collected to estimate the workload generated by each delivery option on the kitchen, ward, and sanitation center. At the kitchen, the work sampling covered filling the bulk containers or individual trays, and preparing them for transport to the wards, but does not include preparation of special diet items. On the wards, it included all efforts related to portioning (with bulk systems) and delivering the trays, and in the sanitation center, covered only sanitation of ward delivery equipment. The results are summarized in Table 16.

The effort expended in the kitchen with the two bulk delivery methods was approximately the same, and considerably less than that required with the insulated trays. However, in the wards, the workload was essentially reversed, so that for the two areas combined, the times were approximately the same for all three options. In the sanitation center, the least effort was needed with the insulated food containers, and the most with the insulated trays. Disposable dinnerware was used with both bulk methods, and disposable inserts were used with the insulated trays. Permanent inserts for the insulated trays increased the workload in the sanitation center by approximately two minutes per meal served.

The greater workload associated with the insulated trays, coupled with their poorer heat maintenance characteristics, greatly increases the peak workload during and close to the regular serving periods, because of need to assemble the trays as closely as possible to the actual serving time. The better heat maintenance characteristics of the bulk delivery method allows filling of containers a longer period of time in advance of delivery, and smoothing out the peak load placed on the food service staff at meal time.

TABLE 16

WORK MEASUREMENT DATA FOR

WARD DELIVERY OPTIONS

	Kitchen	Ward	Sanitation Center	Total
Insulated Food Containers	0.92	2.86	0.63	4.41
Portable Serving Line	0.91	2.92	1.07	4.90
Insulated Trays	3.14	0.85	1.30	5.29

RESULTS AND CONCLUSIONS

Despite the preference of the cooks for the individual insulated trays they are considered to be unsuitable for field use because of their poor temperature maintenance qualities, and the resulting effect on the peak workloads placed on the food service personnel during the meal period. Further, although it cannot be qualified with actual data from the evaluation, it is felt that the food service personnel do not understand the extent of the impact that this mode of delivery could have on the workload in the kitchen and sanitation center when operating a full scale Combat Support Hospital.

The advantages of the portable serving line are the ability to deliver a larger number of hot and cold item in a single unit, and the relative ease of serving from it, as compared to the standard insulated food container. However, acceptable food temperatures can be maintained for no longer than about one hour, and it is apparently difficult to clean properly, even in the XM-75 sanitation center.

On the other hand, the insulated food container has superior temperature maintenance characteristics and is a standard item in the Army inventory. Food service personnel are familiar with its use and limitations, and have been able to operate with it satisfactorily, although not necessarily most efficiently. Therefore, it is recommended that the insulated food container continue to be used for ward patient feeding, until new, improved delivery concepts can be developed.

A major disadvantage of the insulated food container, or any other bulk delivery method, is in transporting individual portions or small quantities of food items for patients on special diets. Typically, special diets, by their very nature, are served in a series of cups to the patient. As a temporary solution, it is recommended that single-serve insulated containers which stack and fit compactly in the insulated food containers be developed for this purpose.

APPENDIX A

TABLE A-1

ESTIMATED EQUIPMENT COSTS FOR

MODIFIED XM-75 AND SANITATION CENTER

Quantity	Equipment Item		Unit Cost	System Cost	Years of Life	Annual Cost
1	Tent, Kitchen (5 Sections)	Frame	$ 700	$ 3,500	8	$ 656
		Fabric	500	2,500	2	1,440
		Fly	200	1,000	1	1,100
1	Tent, Sanitation Center (2 Sections)	Frame	700	1,400	8	262
		Fabric	500	1,000	2	576
		Fly	200	400	1	440
2	Griddle & Steam Tables	Components	2,000	4,000	8	750
		Griddle Top	450	900	1	990
12	Work & Drain Tables	Tops	50	600	4	189
		Legs	80	960	8	180
4	Sanitizing Sinks		600	2,400	8	450
4	Shelving		100	400	2	230
1	Hot Water Heater & Pump		3,800	3,800	8	712
5	Plastic Pallets		40	200	4	63
1	Meat Slicer, Electric		500	500	8	94
1	Vegetable Cutter, Electric		1,000	1,000	8	187
1	Can Opener, Electric		100	100	2	57
1	Serving Utensils		300	300	8	56
30	Jugs, Insulated (10 Kitchen + 2 per Ward)		50	1,500	1	1,650
	Total New Equipment			$26,460		$10,082
6	Range Outfit		$ 850	$ 5,100	4	$ 1,609
7	Burner Units		150	1,050	4	331
2	Accessory Outfits		90	180	3	72
20	Food Containers		80	1,600	2	922
	Total Existing Equipment			$ 7,930		$ 2,934
	TOTAL SYSTEM COST			$34,390		$13,016

TABLE A-2

ESTIMATED EQUIPMENT COSTS FOR

REDUCED XM-75 AND SANITATION CENTER

Quantity	Equipment Item		Unit Cost	System Cost	Years of Life	Annual Cost
1	Tent, Kitchen (2 Sections)	Frame	$ 700	$ 1,400	8	$ 262
		Fabric	500	1,000	2	576
		Fly	200	400	1	440
1	Tent, Saniation Center (2 Sections)	Frame	700	1,400	8	262
		Fabric	500	1,000	2	576
		Fly	200	400	1	440
2	Griddle & Steam Tables	Components	2,000	4,000	8	750
		Griddle Top	450	900	1	990
9	Work & Drain Tables	Tops	50	450	4	142
		Legs	80	720	8	135
3	Sanitizing Sinks		600	1,800	8	337
2	Shelving		100	200	2	115
1	Hot Water Heater & Pump		3,800	3,800	8	712
3	Plastic Pallets		40	120	4	38
1	Serving Utensils		300	300	8	56
9	Jugs, Insulated (5 Kitchen + 2 per Ward)		50	450	1	495
	Total New Equipment			$18,340		$6,326
3	Range Outfit		$ 850	$ 2,550	4	$ 804
4	Burner Units		150	600	4	189
1	Accessory Outfits		90	90	3	36
4	Food Containers		80	320	2	184
	Total Existing Equipment			$ 3,560		$ 1,213
	TOTAL SYSTEM COST			$21,300		$ 7,539